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IoT Trainings Gap Identification Report
D1.4

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3.0	15/4/2022	Updated table 3-1 with Course IDs and technical class and course group.	Mohammad Rashti Salim Al-Wasity

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Disclaimer

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1 INTRODUCTION

1.1 ABSTRACT

The IoTrain project aims to establish a postgraduate taught program (MEng) in the Internet of Things (IoT) in partners universities located in Iran, and Iraq. The project consists of 6 work packages (WP): Preparation, Development, Quality Plan, Dissemination, Exploitation and Management. WP1, Preparation, is further divided into 5 deliverables (tasks), these are, Analysis of existing courses and resources (D1.1), Market needs analysis and goal definition (D1.2), Requirement and Market Needs Analysis (D1.3), IoT Trainings Gap Identification Report (D1.4, this document), and Course Development Plan (D1.5).

Here we produced and finalized deliverable 1.4 report that comprehensively analysed 29 advanced IoT related courses taught in partner universities (items 4.1-4.29, Deliverable 1.1) with respect to well established IoT postgraduate programs in 25 international universities to fulfil the gap in HE is training programs in Iran and Iraq. The analysis performed on three levels: syllabi level and curricula level and both were bounded by the market and industry needs in (Deliverable 1.2, and Deliverable 1.3) as a third level.

The outcome of this deliverable will be served as guideline to the D1.5 (Course Development Plan) and the second work package (WP2) deliverables, especially D2.1 (Course Development Hackathon).

1.2 THE SCOPE OF THE DOCUMENT

The scope of this document is the IoT related education (courses or expertise) in the Iranian and Iraqi HE , IoT programs in the European and other universities, and the market needs w.r.t IoT skills (D1.2, D1.3).

1.3 PURPOSE OF THE DOCUMENT

The aim of this document is to analyse the existing courses listed in D1.1 and the results of the market survey (D1.2) to identify the IoT training gap.

1.4 RELATION TO OTHER DELIVERABLES

This deliverable uses results from D1.1, D1.2, and D1.3. The results of this deliverable will be used as guideline to the D1.5 (Course Development Plan) and work package 2 (development), especially D2.1 (Course Development Hackathon).

1.5 RELATION TO WORKPACKAGES

This deliverable is part of WP1 and will be used for WP2 (Development). It uses the outcome of WP3 and WP4.

2 ANALYSES METHODOLOGIES

Based on a comprehensive survey conducted in deliverable D1.1 (Analysis of existing courses and resources), which covers a wide spectrum of courses taught in partner, and D1.2 (Market needs analysis and goal definition), which identified the industry and market needs using interviews and questionnaires, we prepared this report to systematically analyse these data and compared them to international IoT postgraduate programs. This analysis results in identification of the gaps between HE system in Iraq/Iran and the IoT related programs. This analysis is performed and led by Wasit University (UWA), and the work package leader is Shahid Chamran University (SCU)

We conducted three levels of analyses: syllabi level, curricula level and market requirements level as shown in Figure 2-1 to identify the academic-industry gap from different perspectives as follow:

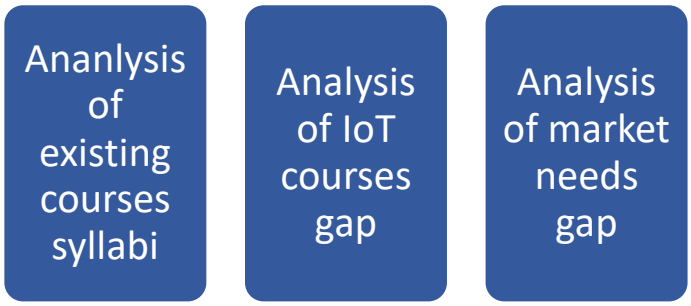

Figure 2-1 Three different analyses levels to identify the academic-industry gap in partner countries.

2.1 ANALYSIS OF EXISTING COURSES SYLLABI

This analysis will be performed by contrasting the syllabi of 29 course that are taught in partner universities with equivalent or similar ones that are exist in 25 international IoT postgraduate program. Additionally, a recommendation would be suggested to match the content of those courses with the industry needs as shown in Figure 2-2.

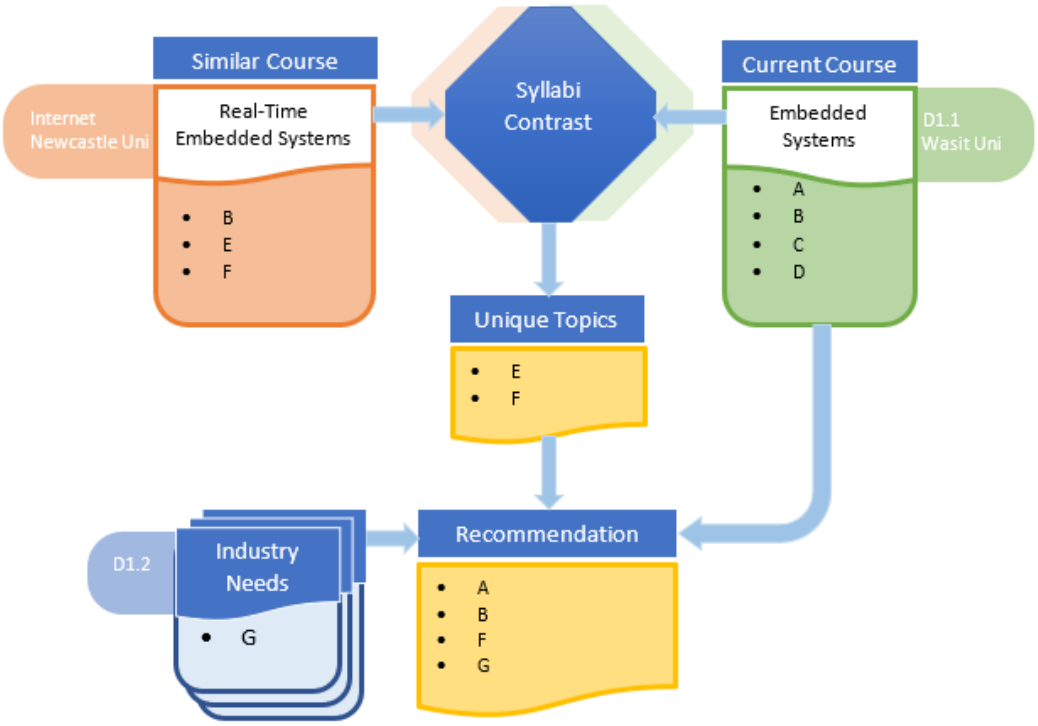

Figure 2-2 Flowchart of performing gap analysis

2.2 ANALYSIS OF IOT COURSES GAP

This analysis will be conducted by comparing 29 IoT related partner curricula with international IoT program curricula to draw a comprehensive view of what courses need to be considered during the course development task (Deliverable 1.5).

2.3 ANALYSIS OF MARKET NEEDS GAP

The is analysis will be based on the results of deliverable 1.2 (Market needs analysis and goal definition) and deliverable 1.3 (IoT Requirement and Market Needs Analysis Event) to summarize the market requirements and identify the gap in the existing courses of the partner countries. The missing courses in partner countries will be considered during course development plan task (deliverable 1.5).

3 EXISTING IOT POSTGRADUATE PROGRAMS AROUND THE WORLD

25 IoT programs were selected based on a Google search for the keywords of ("internet of things", or "IoT") with a selection criterion of: 1) Postgraduate IoT program, 2) Delivered using English language, 3) Reported the curricula/syllabi, as listed in Table 3-1. We then analysed and compared the courses of these programs with the partner existing courses to identify the gap in terms of syllabi and curricula levels.

Table 3-1 Courses that are offered in the international universities. Programs shaded in gray do not have their syllabi details available online.

No.	University	Link	Program name	Technical Class	Course ID	Course Group	Courses
1	University of Essex	https://www.essex.ac.uk/courses/pg00548/1/msc-internet-of-things	Internet of Things	PRJ	247		MSc Project
				CNET	36	Networks	IP Networking and Application
				CPIS	75	Embedded Sys	Advanced Embedded Systems Design
				CPIS	116	Programming	Programming Embedded Systems
				MGM	221	Others	Professional Practice and Research Methodology
				PRJ	235		Group Project
				IOTA	188	IoT Applications	Internet of Things Technology
				CNET	48	Networks	Networking Principles
				SWENG	294	Programming	Introduction to Programming in Python
				SNSEC	255	Security	Computer Security
				SWENG	289	Others	ICT Systems Integration and Management
				CPIS	87	Electronics	Electronic System Design and Integration
				COMM	63	Wireless	Mobile Communications
				AIOT	9	Robotics	Intelligent Systems and Robotics
				SNSEC	265	Security	Network Security
2	Newcastle University	https://www.ncl.ac.uk/postgraduate/degr	Embedded Systems and Internet of	CPIS	117	Embedded Sys	Real Time Embedded Systems
				IOTA	203	IoT Applications	M2M Technology Internet of Things
				PRJ	237		Individual Project
				CNET	52	Wireless	Wired and Wireless Communication Networks and Security
				CNET	30	Networks	Internet of Things and Wireless Sensor Networks
				CPIS	119	Architecture	Reconfigurable Hardware Design
				SWENG	290	Image Processing	Image Processing and Computer Vision
3	Polytechnic University of Madrid	https://masteriot.etsist.upm.es/?lang=en	Internet of Things (IoT)	CPIS	89	Embedded	Embedded platforms and communications for IoT
				SWENG	305	programming	Mobile Devices Programming
				CNET	50	Networks	Sensor Networks
				CPIS	84	Computational	Cyber-physical systems modelling
				IOTA	181	Distributed Sys	Distributed Systems for IoT
				IOTA	171	Architecture	Architectures and service platforms
				IDDS	153	Computational	Information Models
				SNSEC	275	Security	Security for IoT Applications
				IDDS	137	Big Data	Big Data Applications
				IOTA	174	Cloud Computing	Cloud computing for IoT
				IDDS	154	AI	Intelligent IoT Applications
				PRJ	243		Master Thesis
4	Purdue University	https://engineering.purdue.edu/ECE/Academics/PMP/Areas/internet-of-things	Internet of Things	CPIS	122	Electronics	System-on-Chip Design
				CPIS	112	Electronics	MOS VLSI Design
				CPIS	94	Embedded Sys	Embedded Systems
				IOTA	176	Architecture	Computer Design and Prototyping
				SWENG	303	Architecture	Mobile Computing Systems
				IOTA	194	Operating Sys	Introduction to Operating Systems
				CNET	23	Networks	Computer Network Systems
				CPIS	115	Electronics	Primer on Semiconductor Fundamentals
				CPIS	98	Electronics	Essentials of MOSFETs
				SWENG	314	Data Base	Primer on Analysis of Experimental Data & Design of Experiments
				SWENG	283	Computational	Applied Algorithms
				SWENG	285	Computational	Computational Models and Methods
				IDDS	162	AI	Machine Learning - I
				CPIS	111	Electronics	Microfabrication Fundamentals
				COMM	65	Communications	Primer on RF Design

				SWENG	311	programming	Object-Oriented Programming in C++ and Java
				SWENG	316	programming	Programming Parallel Machines
				SWENG	298	Computational	Linear Algebra
				SWENG	280	Computational	Advanced Mathematics for Engineers and Physicists - I
5	EURECOM	https://www.eurecom.fr/en/teaching/master-science/master-degree-internet-of-things-IoT	INTERNET OF THINGS (IOT)	COMM	64	Computational	Mobility Modelling
				COMM	62	Wireless	Mobile communication systems
				CNET	31	Networks	Introduction to computer networking
				IOTA	179	Distributed Sys	Distributed Systems and Cloud computing
				MGM	226	Other	Standardization activities
				CPIS	123	Embedded Sys	UML for Embedded Systems
				CNET	25	Architecture	Computing and internet
				IOTA	204	Operating Sys	Operating systems
				SNSEC	278	Security	System and Network Security
				IDDS	126	Data Base	Advanced Data Science Topics
				IDDS	163	AI	Machine Learning and Intelligent System
				SWENG	300	Mobile App	Mobile application and services
				CNET	44	Networks	Network Modelling
				OTH	230	Computational	Fundamentals of Optimisation
				SWENG	323	Programming	Software development methodologies
				CNET	33	IoT applications	IoT Application Protocols
				CNET	34	IoT network	IoT Communication Protocols
				SWENG	282	Semantic Web	An Introduction to Semantic Web technologies
				IDDS	134	AI	Algorithmic Machine Learning
				IDDS	149	AI	Deep Learning
				CNET	40	Networks	Mobile Networking
				CNET	45	Networks	Network Softwarization
				SNSEC	275	Distributed Sys	Security applications in networking and distributed systems
				PRJ	242		Master Project
6	University of the West of Scotland	https://www.uws.ac.uk/study/postgraduate/postgraduate-course-	Internet of Things	SWENG	306	Networks	Mobile Networks and Smartphone Applications
				IDDS	147	Big Data	Data Mining and Visualization
				MGM	216	Other	Ethics for IT professionals
				SWENG	309	Programming	Object-oriented Analysis and Design
				MGM	223	Other	Research Design and Methods
				CNET	28	Networks	Emerging Topics in Smart Networks
				PRJ	244		Master's project
				IDDS	125	Data Base	Advanced Data Science
				CNET	22	Wireless	Advanced Wireless Networking Technologies
				AIOT	6	Other	eHealth and Healthcare Systems
				AIOT	8	AI	Intelligent Systems
				AIOT	10	IoT Applications	Internet of Things (IoT) and Applications
7	Bournemouth University	https://www.bournemouth.ac.uk/study/courses	Internet of Things	CNET	37	Networks	Mobile & Wireless Networks
				CNET	54	Networks	Wireless, Sensor and Actuator Networks
				SNSEC	273	Security	Security and Privacy in IoT
				MGM	224	Other	Research Methods & Professional Issues
				PRJ	236		Individual Masters Project
				IOTA	172	Cloud Computing	Cloud Computing
				SNSEC	253	Other	Blockchain & Digital Futures
				SWENG	287	HMI	Human Centred Design
				AIOT	18	AI	Smart Systems
8	University of	https://www.southampton.ac.uk/courses/intern	Internet of Things	CPIS	99	Embedded Sys	Foundation of Embedded IoT systems
				CNET	35	IoT Network	IoT Networks
				PRJ	248		MSC project
				SNSEC	269	Embedded Sys	Secure Hardware and Embedded Devices
				AIOT	5	Robotics	Biologically Inspired Robotics
				CPIS	83	Other	Biometrics
				SNSEC	258	Cryptography	Cryptography
				CPIS	90	Embedded Sys	Embedded Processors
				IDDS	164	AI	Machine Learning for Wireless Communications

				CPIS	81	Electronics	Analogue and Mixed Signal Electronics
				SWENG	301	Mobile App	Mobile Applications Development
				MGM	220	Data Base	Open Data Innovation
9	University of Florida	https://dep.fiu.edu/academics/degrees/graduate/msiot-2	Internet of Things (IoT)	CNET	19	IoT Network	Advanced IoT Communications and Networking
				SNSEC	252	Security	Advanced Security of Internet of Things and Cyber-Physical Systems
				CPIS	77	DSP	Advanced Sensor Signal Processing
				COMM	56	Antenna	Antennas for Wireless and Body-Centric Communications
				IOTA	208	Other	Power Aware Computing
				SNSEC	266	Security	Network Security
				IDDS	129	Big Data	Advanced IoT and Sensor Big Data Analytics
				IDDS	128	Cloud Computing	Advanced IoT Analytics with Cloud Services
				IDDS	132	AI	Advanced Sensor and IoT Data Analytics with Deep Learning
				IDDS	130	AI	Advanced IoT Applied Machine Learning
10	The University of New Mexico	http://online.unm.edu/online-degrees/computer-engineering-	Internet of Things (IoT)	IDDS	161	AI	Machine Learning
				IOTA	192	IoT Sys Design	Introduction to Internet of Things
				CNET	20	Networks	Advanced Networking
				PRJ	234		Graduate Seminar
				SNSEC	260	Security	Hardware-Oriented Security and Trust
				CPIS	102	Architecture	Hardware Software Codesign with FPGAs
				SNSEC	262	Security	Introduction to Cybersecurity
				IOTA	190	Cloud Computing	Introduction to Cloud Computing
				COMM	71	Communications	Satellite Communications
				IDDS	166	AI	Problems in Machine Learning
				OTH	232	Computational	Stochastic Processes
				OTH	231	DSP	Optimal Estimation and Filtering
11	Queen Mary University of London	https://www.qmul.ac.uk/postgraduate/taught/coursefinder/courses/internet-	Internet of Things	SWENG	307	Mobile App	Mobile Services
				SNSEC	272	Security	Security and Authentication
				PRJ	249		MSC project
				IOTA	193	IoT Sys Design	Introduction to IoT
				COMM	58	IoT Network	Enabling Communication Technologies for IoT
				CPIS	86	Electronics	Electronic Sensening
				CNET	39	Wireless	Mobile and WLAN Technologies
				IDDS	158	AI	Machine Learning
				OTH	229	Computational	Applied Statistics
				IDDS	139	Big Data	Big Data Processing
				SWENG	326	Semantic Web	The Semantic Web
				IDDS	152	Other	Digital Media and Social Networks
				IDDS	142	Cloud Computing	Cloud Analytics
				COMM	55	Wireless	5G Mobile and Beyond
12	University at Buffalo	https://engineering.buffalo.edu/ee/grad/graduate_programs/engineering-sciences-iot.html	Engineering Sciences MS (Focus on Internet of Things)	COMM	67	Communications	Principles of Modern Digital Communications
				CNET	49	Networks	Principles of Networking
				CPIS	124	Sensors	Wearable and Implantable Sensors
				IDDS	168	Big Data	Special Topics: Data Analytics
				IOTA	210	IoT Applications	Special Topics: Internet of Things
				CPIS	101	Electronics	Fundamentals of Solid-State Devices
				COMM	70	Communications	RF & Microwave Circuits
				COMM	61	Wireless	MIMO Wireless Communications
				COMM	57	Communications	Digital Communication System Design (shown as EE 550 Special Topics online)
				COMM	69	Communications	RF & Microwave Circuits 2
				CPIS	110	Electronics	Microelectronic Fabrication Laboratory
				CPIS	79	Electronics	Analog Integrated Circuits Layout
				CNET	51	Networks	Programmable Networks
				CNET	46	Networks	Networked Systems Design
				COMM	66	Wireless	Principles of Cellular Communications Networks

				COMM	72	Wireless	Special Topics: From LTE to 5G and Cyber Physical Systems
				CPIS	103	DSP	Introduction to Digital Signal Processing
				CPIS	114	Electronics	Power Electronics
				SWENG	317	Programming	Programming with Python
				SWENG	284	Other	Commerce Technology
				CPIS	118	Embedded Sys	Realtime & Embedded Systems
				IDDS	156	AI	Introduction to Pattern Recognition
				SNSEC	256	Security	Computer Security
				SNSEC	279	Security	Wireless Networks Security
				IOTA	195	Distributed Sys	Introduction to Parallel and Distributed Processing
				IDDS	155	AI	Introduction to Machine Learning
				IOTA	205	Distributed Sys	Parallel & Distributed Processing
				IDDS	145	Big Data	Data Mining
				IDDS	170	AI	Techniques of Artificial Intelligence
				IDDS	150	AI	Deep Learning
13	University of Bradford	https://www.bradford.ac.uk/courses/pg/internet-of-	Internet of Things (IoT)	IOTA	187	IoT Sys Design	Internet of Things (IoT)
				SWENG	302	Mobile App	Mobile Application Development
				IDDS	127	IoT Sys Design	Advanced IoT (Data Science for IoT)
				PRJ	246		MSc Group Project
				PRJ	233		Dissertation
				IDDS	140	Big Data	Big Data Systems and Analytics
				IDDS	141	Big Data	Big Data Visualisation
				SWENG	322	Programming	Software Development
				IDDS	131	AI	Advanced Machine Learning
				MGM	225	Other	Risk Assessment and Management
14	Stanford University	https://online.stanford.edu/programs/internet-things-graduate-program	Internet of Things Graduate Program	CPIS	107	DSP	Introduction to Statistical Signal Processing
				COMM	59	Communications	Introduction to Digital Communication
				COMM	73	Wireless	Wireless Communications
				SWENG	327	Semantic Web	Web Applications
				SNSEC	254	Security	Computer and Network Security
				CPIS	100	Electronics	Fundamentals of Analog Integrated Circuit Design
				CPIS	76	Electronics	Advanced Integrated Circuit Design
				AIOT	4	Other	Biochips and Medical Imaging
				CPIS	80	Electronics	Analog-Digital Interface Circuits
				IOTA	191	IoT Applications	Introduction to Internet of Things
				AIOT	3	Robotics	Autonomous Implantable Systems
				CPIS	105	Electronics	Introduction to Micro and Nano Electromechanical Systems
				CPIS	106	Sensors	Introduction to Sensors
15	University of	https://catalogue.usc.edu/preview_progra	Internet of Things	SNSEC	261	Security	Introduction to Computer and Network Security
				CPIS	104	Embedded Sys	Introduction to Embedded Systems
				IOTA	182	Distributed Sys	Distributed Systems for the Internet of Things
				IOTA	177	Architecture	Computing Platforms and Paradigms
				SWENG	321	Programming	Software Design for Electrical Engineers
				SWENG	315	Programming	Principles of Software Development
				CNET	32	Networks	Introduction to Computer Networks
				IOTA	206	Distributed Sys	Parallel and Distributed Computation
16	La Trobe University	https://www.latrobe.edu.au/courses/master-of-internet-of-	Master of Internet of Things				
				SWENG	286	Data Base	Database Fundamentals
				SWENG	291	Data Base	Information Technology Fundamentals
				AIOT	12	IoT Applications	IoT Technology and Applications
				IDDS	165	Data Base	Probability And Statistics for Data Science
				MGM	222	Other	Professional Practices and Entrepreneurship in Information Technology
				SWENG	295	IoT Programming	IoT Programming
				IOTA	198	IoT Programming	IoT Protocols and Platforms
				PRJ	250	Other	Project Management
				SNSEC	274	Security	Security and Privacy in IoT

				SWENG	293	Programming	Introduction To Programming
				SWENG	310	Programming	Object-Oriented Programming Fundamentals
17	Asian Institute of Technology	https://set.ait.ac.th/programs/information-and-communications-technologies/iot/	Masters in IoT Systems Engineering	IOTA	189	IoT Design	Internet of Things Technology and Design
				CNET	53	IoT Network	Wireless Technologies for Internet of Things
				PRJ	239	IoT Application	Internet of Things Seminar
				MGM	217	Other	In the Mind of an Entrepreneur
				CNET	26	Networks	Cross-Layer Design for Wireless Networks
				IDDS	159	AI	Machine Learning
				CPIS	91	Embedded Sys	Embedded System Architecture
				CPIS	92	Embedded Sys	Embedded System Design
				CPIS	120	Sensors	Sensing and Actuation
						AI	AI and Neuro-Fuzzy Theory
				CPIS	74	Other	Additive Manufacturing and Reverse Engineering
				CNET	24	Networks	Computer Networks
				CNET	21	IoT Application	Advanced Topics in Internet Technology
				SWENG	299	Mobile App	Mobile Application
				IOTA	173	Cloud Computing	Cloud Computing
				SNSEC	263	Security	IoT Security
18	University Bourgogne Franche-Comté	https://www.ubfc.fr/en/masters/master-iot/	Master in Internet of Things (IoT)	SWENG	304	Mobile App	Mobile development
				CNET	29	Networks	Infrastructure and routing for connected objects
				IDDS	146	Big Data	Data mining
				MGM	251	Other	Team management and communication
				COMM	68	Networks	Radio networks
				CPIS	113	Mobile App	Positioning systems: techniques and applications
				CPIS	95	Embedded Sys	Embedded systems
				IOTA	175	Cloud	Cloud infrastructure and virtualization
				PRJ	245	Project	Mini project at the lab
				IDDS	151	AI	Deep learning (DL) for IoT
				SNSEC	276	Security	Security for connected objects
				AIOT	13	Other	Mobility in smart cities
				SWENG	308	Robotics	Modular robots programming and swarm robotics
				SWENG	281	IoT Applications	Agent-based Modeling and Simulation for IoT
				SWENG	312	IoT Applications	Perception and interactions for IoT
19	École Polytechnique	https://programmes.polytechnique.edu/en/mas	Internet of Things: Innovation and	SWENG	313	Programming	Practical C and Java Programming, Algorithms, and Data Structure
				IOTA	183	Architecture	From the Internet to the IoT – The Fundamentals of Modern Computer
				MGM	212	Other	Business Models in the Digital Era
				CPIS	85	Electronics	Digital and Analog Electronics
				MGM	214	Other	Corporate Finance for Entrepreneurs
				MGM	227	Other	Sustainable Strategy and Business Models
20	University of the Aegean	https://msc.icsd.aegean.gr/iot/?lang=en	MSc Internet of Things: Intelligent Environments in Next Generation	IDDS	160	AI	Machine Learning
				CNET	27	Networks	Design, Development and Performance Evaluation of Next-Generation Networks
				IOTA	207	Architecture	Pervasive Computing Systems
				AIOT	1	Mobile App	Algorithms, Combinatorial Optimization and Financial Applications
				AIOT	11	IoT Applications	IoT Technologies and Applications
				COMM	60	IoT Network	IoT Communication Technologies
				CPIS	97	Embedded Sys	Embedded Systems and IoT
				SNSEC	259	Security	Future Internet Security and Privacy
				AIOT	14	Robotics	Robotics and Computer Vision
				CNET	41	Networks	Modern Networks and IoT Interfacing
				SWENG	319	Semantic Web	Semantic Web
				IDDS	136	Big Data	Big Data and Data Mining

21	Technological University Dublin	https://www.tudublin.ie/study/postgraduate/courses/internet-of-	Master of Engineering in Internet of Things Technologies	CPIS	93	Embedded Sys	Embedded Systems
				SWENG	292	Other	Information Transmission & Management
				SWENG	324	Programming	Software Engineering
				SWENG	325	Computational	Statistical Analysis for Engineers
				IOTA	200	IoT Sys Design	IoT Systems
				SNSEC		Cryptography	Secure Communication & Cryptography
				MGM	228	Other	Technology & Innovation Management
						Other	Geodata Provisions
						DSP	Advanced Signal Processing
				SNSEC	267	Security	Network Security
				IDDS	167	Big Data	Programming for Big Data
				SWENG	325	Computational	Statistical Analysis for Engineers
22	University of Calabria	https://www.dimes.unical.it/content/computer-engineering-iot	Computer Engineering for the Internet of Things	IOTA	180	Cloud Computing	Distributed Systems and Cloud/Edge Computing for IoT
				CNET	42	Communications	Network Aspects of The Internet of Things - Module 1: Communication Protocols for The IoT
				MGM	213	IoT Applications	Business Models of IoT Applications
				AIOT	15	AI	Smart Agents and System Analysis Design and Implementation
				IDDS	138	Big Data	Big Data Management
				CPIS	88	Electronics	Electronics for IoT Devices
				CNET	43	Networks	Network Aspects of The Internet of Things - Module 2: Wireless Networking. Mutual Wireless Devices and Networks
				CPIS	109	Programming	Low Level and Embedded System Programming
				CPIS	178	IoT Design	Control Techniques for IoT Systems
				IDDS	135	Big Data	Big Data Analytics
				SWENG	296	IoT Programming	IoT Systems - Module 1 - IoT Programming
				SNSEC	264	Security	IoT Security
				SWENG	297	IoT Programming	IoT Systems - Module 2 - IoT Development Methodologies and Tools
23	Universita degli studi di	https://corsi.unisa.it/informatica-magistrale/en/home	Master of Science in Computer Science / Specialisation:	IOTA	186	IoT Applications	Internet of Things
				SNSEC	257	Security	Context Aware Security Analytics in Computer Vision
				SWENG	320	Programming	Software Dependability
				IOTA	209	IoT Programming	Serverless Computing for IoT
				IDDS	157	Data Base	IoT Data Analytics
						Security	Security
				SWENG	288	HMI	Human Computer Interaction and Experience Design in the Internet of Things
				SWENG	318	Programming	Robot Programming
				CPIS	96	Embedded Sys	Embedded Systems
24	University of	https://iot.usal.es/en	Master in Internet of Things	IOTA	185	IoT Application	Internet of Things
				IOTA	196	IoT Design	IoT INFRASTRUCTURES AND COMMUNICATIONS
				IOTA	108	IoT Design	IoT DEVICES
				IOTA	108	IoT Application	APPLICATIONS OF IoT
				AIOT	17	AI	Smart Cities
				IOTA	184	Electronics	Integration of Systems and Tools
				IDDS	148	Data Base	Data Sciences
				AIOT	16	AI	Smart Buildings
25	Technical	https://www.technikum-	Internet of Things und	IDDS	138	Data Base	Data Management
				MGM	218	Other	Innovation and Technology Management
				IOTA	197	IoT Programming	IoT Operating Systems
				IOTA	199	IoT Design	IoT system models
				CNET	38	Wireless	Mobile and Wireless Systems
				CNET	47	Networks	Networking

				IDDS	143	Data Base	Data Analysis
				MGM	219	Security	IT and Data Protection Law
				IOTA	201	IoT Design	IoT Systems Development
				IOTA	202	IoT Design	IoT Technologies
				SNSEC	270	Security	Security
				CPIS	121	Sensors	Sensor / Actor Systems & Control Theory
				CPIS	82	Robotics	Automation
				MGM	215	Other	Digital Leadership

4 ANALYSIS OF INDIVIDUAL COURSES

Table 3-1 has identify a pile of courses that are offered as part of IoT undergraduate and postgraduate programs in the European, Asian, and American countries. Some of these courses or similar ones already exist in partner and program countries.

We grouped partner courses into 18 course groups as listed in Table 4-1, then we analysed and compared them and their syllabi to the IoT programs offered in international universities. Few partner courses have no similar ones offered in internationally, therefore they were excluded from this analysis as listed in Table 4-2. On the other hand, international universities offer other courses that are not exist in any of the partner universities. Similarity to the existing courses, we grouped them into 10 course groups as listed in table Table 4-3. Subsequently, all the existing partner and the international courses were assigned to the course groups listed in Table 4-1, Table 4-2, or Table 4-3.

Partner countries offered the common course groups in different weights according to their importance as shown in Figure 4-1.

Table 4-1 Common courses between partner countries and international countries

#	Course Group Name
1	Embedded Systems
2	Cryptography
3	Machine Learning, Deep Learning, AI
4	Big Data and Data Mining
5	Cloud Computing
6	Semantic Web
7	Wireless Communications
8	Digital Signal Processing
9	Computer Networks
10	Security
11	IoT Networks
12	Distributed systems
13	Database
14	Communications
15	Computer Architecture
16	Antennas and Propagation
17	Programming
18	Robotics

Table 4-2 Existing partner ccourses that are excluded from the gap analysis as they are not being offered by international universities.

#	Course Group	Excluded Courses
1	Fault Tolerant Systems	Fault Tolerant Systems
2	Electromagnetic Fields	Electromagnetic Fields I, II
3	Multimedia	Multimedia
4	Others	Information Retrieval
		Foundations of Natural Language Processing

Table 4-3 Ccourses that are offered in international universities buy not in any of the partner universities.

#	Course Group Name
1	Mobile application development
2	Operating systems
3	Imaging processing
4	Computational Modelling and statistical analysis
5	Human computer interaction
6	Sensors and Actuators
7	Electronics
8	IoT Applications
9	IoT System Design
10	IoT Programming

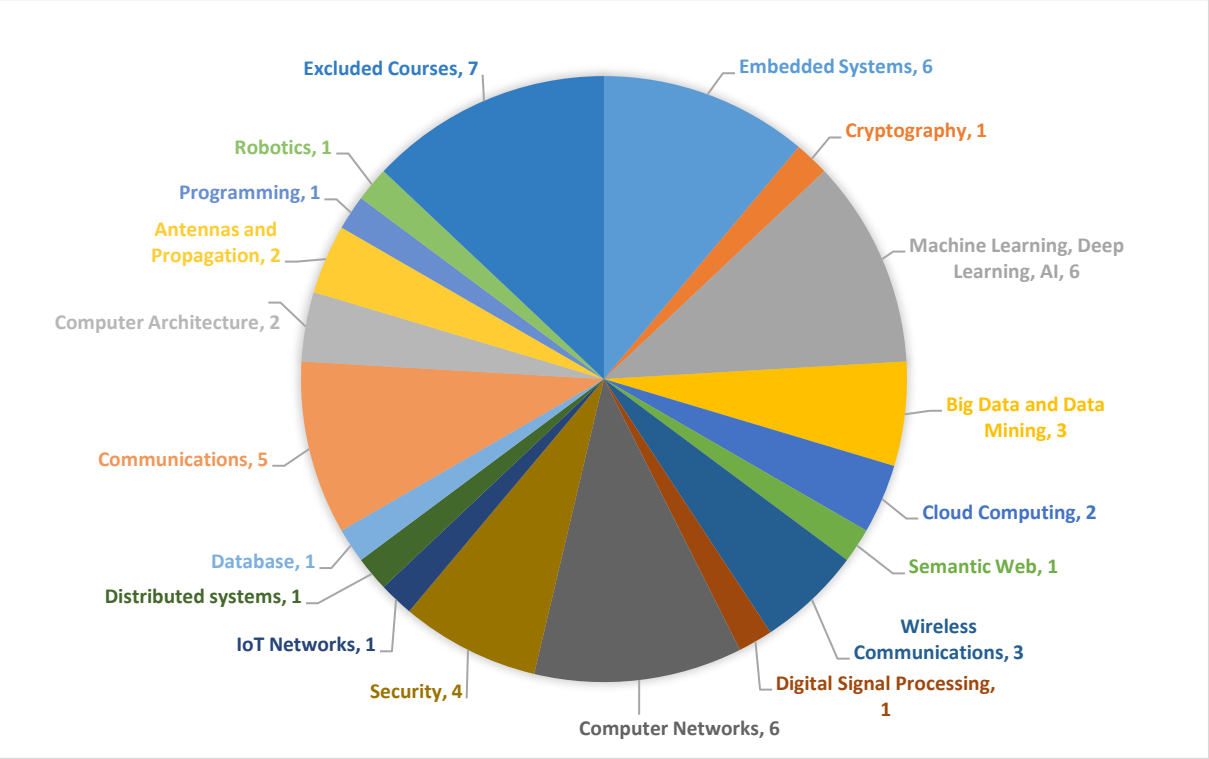

Figure 4-1 Number of common courses across partner countries programs

4.1 EMBEDDED SYSTEMS

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-4. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-5.

Table 4-4 Common courses in the field of Embedded Systems between partner and international countries

Embedded Systems		
Uni	**Existing Courses**	**International Courses**
SCU	Real-Time and Embedded Systems	Advanced Embedded Systems Design

IBS SCU USB	Real-Time Embedded Systems	Programming Embedded Systems
UWA	Embedded System I	Real Time Embedded Systems
UWA	Embedded System II	Embedded platforms and communications for IoT
IBS	Foundations of Embedded IOT Systems	UML for Embedded Systems
IAU	Embedded Processors	Foundation of Embedded IoT systems
		Secure Hardware and Embedded Devices
		Embedded Processors
		Realtime & Embedded Systems
		Introduction to Embedded Systems
		Embedded System Architecture
		Embedded System Design
		Embedded Systems and IoT
		Low Level and Embedded System Programming
		Embedded Systems

Table 4-5 Summery of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
University of Essex	Programming Embedded Systems	Real-time Scheduling and Real-time Operating Systems
		Multi-core based Embedded Systems
		Programming Multi-core based Embedded Systems
		Tasks/Processes and their Scheduling
	Advanced Embedded Systems Design	Processor architectures
		System design methodologies
Newcastle University	Real Time Embedded Systems	Concurrent schedulers
Suggested modifications to match the partner course with their market needs		Embedded Processors
		Raspberry Pi
		PLC
		PTC
		Siemens
		ABB
		Schneider
		VMs

4.2 CRYPTOGRAPHY

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in **Error! Reference source not found.**. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in **Error! Reference source not found.**.

Table 4-6 Common courses in the field of Cryptography between partner and international countries

Cryptography		
Uni	**Existing Courses**	**International Courses**
IAU	Cryptography	Secure Communication & Cryptography
		Cryptography

Table 4-7 Summery of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
The existing course is up to date		
Suggested modifications to match the partner course with their market needs		WPA/WPA2
		PGP
		Authentication
		MPU

4.3 MACHINE LEARNING, DEEP LEARNING, AND AI

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-8. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-9.

Table 4-8 Common courses in the field of Machine Learning, Deep Learning, AI between partner and international countries

Artificial Intelligence		
Uni	**Existing Courses**	**International Courses**
SCU	Advanced Artificial Intelligence	Techniques of Artificial Intelligence
UWA	Artificial Intelligence	Deep Learning
USU	Artificial Intelligence	Advanced Sensor and IoT Data Analytics with Deep Learning
USU	Soft Computing	Deep learning for IoT
IAU	Machine Learning for Wireless Communications	Machine Learning
IAU	Deep Learning	Machine Learning and Intelligent System
		Machine Learning for Wireless Communications
		Introduction to Pattern Recognition

Table 4-9 Summary of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
University at Buffalo	Techniques of Artificial Intelligence	Cognitive Architectures and General Intelligent Systems
Newcastle University	Machine Learning	Data Representation
		Feature Extraction Methods
University at Buffalo	Introduction to Pattern Recognition	Nonparametric Techniques in Machine Learning
		Algorithm-Independent Machine Learning
University at Buffalo	Deep Learning	Architecture specialization for deep learning
		GPGPU, domain specific processors, FPGA/ASIC-based accelerators
		Deep learning algorithms in embedded resource constrained systems
Suggested modifications to match the partner course with their market needs		OpenCV
		Tensorflow
		Python
		PyTorch
		Numpy

4.4 BIG DATA

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-20. The contrast in syllabi

between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-21.

Table 4-10 Common courses in the field of Big Data partner and international countries

Big Data		
Uni	**Existing Courses**	**International Courses**
IAU	Big Data	Big Data Applications
IBS	Data Mining	Advanced IoT and Sensor Big Data Analytics
USU	Data Mining	Big Data Processing
		Big Data Systems and Analytics
		Big Data Visualisation
		Big Data and Data Mining
		Programming for Big Data
		Big Data Management
		Big Data Analytics
		Data Mining and Visualization
		Data Mining
		Big Data and Data Mining

Table 4-11 Summery of the gap in the syllabi and the market needs

University Name	**Course Name**	**Main topics that are covered in this course and not in the existing partner courses**
University of Bradford	Big Data Visualisation	Visualization techniques and applications to real-life problems
		Knowledge extraction from big data using data visualizations
		Interpretation of multidimensional, big and complex data formats
Suggested modifications to match the partner course with their market needs		

4.5 CLOUD COMPUTING

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-12. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-13.

Table 4-12 Common courses in the field of Cloud Computing between partner and international countries

Cloud Computing		
Uni	**Existing Courses**	**International Courses**
IAU	Cloud and Fog Computing	Cloud computing for IoT
USU	Cloud Computing	Distributed Systems and Cloud computing
		Cloud Computing
		Advanced IoT Analytics with Cloud Services
		Introduction to Cloud Computing
		Cloud Analytics
		Cloud Computing
		Cloud infrastructure and virtualization
		Distributed Systems and Cloud/Edge Computing for IoT

Table 4-13 Summery of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
Bournemouth University	Cloud Computing	Migration IT infrastructure to the cloud
The University of New Mexico	Introduction to Cloud Computing	Role of Cloud Computing in IoT
		AWS Components
		Lambda
		Connecting a web application to AWS IoT using MQTT
Suggested modifications to match the partner course with their market needs		Virtualization
		Containers
		Google cloud
		Amazon AWS

4.6 SEMANTIC WEB

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-14. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-15.

Table 4-14 Common courses in the field of Semantic Web partner and international countries

Semantic Web		
Uni	**Existing Courses**	**International Courses**
IAU	Semantic Web	An Introduction to Semantic Web technologies
		The Semantic Web

Table 4-15 Summery of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
The existing course is up to date		
Suggested modifications to match the partner course with their market needs		

4.7 WIRELESS COMMUNICATIONS

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-16. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-17.

Table 4-16 Common courses in the field of Cellular and Wireless Communications between partner and international countries

Cellular and Wireless Communications

Uni	Existing Courses	International Courses
IAU	Cellular And Wireless Communications	Mobile Communications
WU	Wireless Communications	Mobile communication systems
USU	Mobile Computing	Mobile application and services
		Mobile Networking
		Mobile Networks and Smartphone Applications
		Mobile & Wireless Networks
		Mobile and WLAN Technologies
		5G Mobile and Beyond
		Mobile and Wireless Systems
		Principles of Cellular Communications Networks
		Wired and Wireless Communication Networks and Security
		Advanced Wireless Networking Technologies
		Mobile & Wireless Networks
		Wireless, Sensor and Actuator Networks
		MIMO Wireless Communications
		Wireless Communications
		Cross-Layer Design for Wireless Networks
		Wireless Networking. Mutual Wireless Devices and Networks
		Mobile and Wireless Systems
		Satellite Communications

Table 4-17 Summery of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
EURECOM	Advanced Topics in Wireless Communications	Massive MIMO
		Interference management
		Device coordination
		5G techniques
University of the West of Scotland	Advanced Wireless Networking Technologies	autonomous network management for 5G networks.
Suggested modifications to match the partner course with their market needs		Bluetooth
		Mobile IP
		IEEE 802.16
		LTE
		6LoWPAN

4.8 DIGITAL SIGNAL PROCESSING

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-18. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-19.

Table 4-18 Common courses in the field of Digital Signal Processing between partner and international countries

Digital Signal Processing		
Uni	**Existing Courses**	**International Courses**
IAU	Introduction To Digital Signal Processing	Introduction to Digital Signal Processing

Table 4-19 Summary of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
The existing course is up to date		
Suggested modifications to match the partner course with their market needs		Industrial interfaces
		I/O standards

4.9 COMPUTER NETWORKS

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-20. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-21.

Table 4-20 Common courses in the field of Computer Networks partner and international countries

Computer Networks		
Uni	**Existing Courses**	**International Courses**
SCU	Fundamentals of Wireless Networks	Wired and Wireless Communication Networks and Security
SCU IBS USB	Advanced Computer Networks	Programmable Networks
SCU IBS USB	Advanced Computer Networks	Design, Development and Performance Evaluation of Next-Generation Networks
UWA	Computer Networks I	Computer Networks
UWA	Computer Networks II	Introduction to Computer Networks
USU	Computer Networks	Modern Networks and IoT Interfacing
		IP Networking and Application
		Networking Principles
		Computer Network Systems
		Advanced Networking
		Principles of Networking
		Networked Systems Design

Table 4-21 Summery of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
Newcastle University	Wired and Wireless Communication Networks and Security	Fundamentals of privacy and security as applied to modern communications
		Wireless technologies (IEEE 802.11, IEE 802.15, IEEE802.16)
		Wireless communications Systems, 4G/5G, IoT
Suggested modifications to match the partner course with their market needs		Cisco
		IEEE standards
		Extreme Networks

4.10 SECURITY

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-22. The contrast in syllabi

between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-23.

Table 4-22 Common courses in the field of Security partner and international countries

Security		
Uni	**Existing Courses**	**International Courses**
IAU	IoT Security	Computer Security
SCU	Network Security	Network Security
UWA	Information Security	Wired and Wireless Communication Networks and Security
USU	Computer Security	Security for IoT Applications
		System and Network Security
		Security applications in networking and distributed systems
		Security and Privacy in IoT
		Advanced Security of Internet of Things and Cyber-Physical Systems
		Network Security
		Hardware-Oriented Security and Trust
		Introduction to Cybersecurity
		Computer Security
		Wireless Networks Security
		Computer and Network Security
		Introduction to Computer and Network Security
		Security and Privacy in IoT
		IoT Security
		Security for connected objects
		Future Internet Security and Privacy
		Network Security
		Context Aware Security Analytics in Computer Vision
		Security

Table 4-23 Summary of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
University of Florida	Advanced Security of Internet of Things and Cyber-Physical Systems	Attacks against IoT system (hardware and software)
		Attacks against IoT network protocols
		Attacks against industry IoT
		IoT communication protocol Message
		Queuing Telemetry Transport
		Amazon AWS IoT
The University of New Mexico	Hardware-Oriented Security and Trust	Emerging security and trust issues associated with hardware systems
		Attack scenarios that threaten hardware systems
		Security and trust primitives on ASIC and FPGA integrated circuits
Bucks County Community College	Introduction to Cybersecurity	Wireless Security
		Physical Security
		Enforcing Confidentiality with Encryption, Certificates and PKI
Suggested modifications to match the partner course with their market needs		WPA/WPA2
		Authentication
		WEP

4.11 IOT NETWORKS

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-24. The contrast in syllabi

between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-25.

Table 4-24 Common courses in the field of IoT Networks partner and international countries

IoT Networks		
Uni	**Existing Courses**	**International Courses**
IAU	IoT Networks	IoT Networks
		Communication Protocols for The IoT
		Modern Networks and IoT Interfacing
		Internet of Things and Wireless Sensor Networks
		Internet of Things and Wireless Sensor Networks
		Enabling Communication Technologies for IoT
		Embedded platforms and communications for IoT

Table 4-25 Summery of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
University of Southampton	IoT Networks	Standardisation of communication protocols
Queen Mary University of London	Enabling Communication Technologies for IoT	Radio Frequency Identification (RFID)
		Near Field Communication (NFC)
		Wireless Sensor Networks
Suggested modifications to match the partner course with their market needs		Zigbee
		MQTT

4.12 DISTRIBUTED SYSTEMS

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-26. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-27.

Table 4-26 Common courses in the field of Distributed systems between partner and international countries

Distributed systems		
Uni	**Existing Courses**	**International Courses**
SCU USB	Distributed Systems	Distributed Systems for IoT
		Distributed Systems and Cloud computing
		Security applications in networking and distributed systems
		Introduction to Parallel and Distributed Processing
		Parallel & Distributed Processing
		Distributed Systems for the Internet of Things
		Parallel and Distributed Computation
		Distributed Systems and Cloud/Edge Computing for IoT

Table 4-27 Summery of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
Polytechnic University of Madrid	Distributed Systems for IoT	Kafka Technology
		Zookeeper Technology
Purdue University	Programming Parallel Machines	Automatic Parallelization
		Explicit Program Parallelization
		MPI
		Pthreads
		Programming Methodologies and Tools
Suggested modifications to match the partner course with their market needs		Cluster Computing
		Data Analytics
		Internet Services
		HPC

4.13 DATABASE

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-28. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-29.

Table 4-28 Common courses in the field of Database between partner and international countries

Database		
Uni	**Existing Courses**	**International Courses**
UWA	Advanced Database	Database Fundamentals

Table 4-29 Summary of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
La Trobe University	Database Fundamentals	Stored Procedures, Triggers
		Functional Dependencies
		Distributed and Cloud Databases
		Big Data & NoSQL
Suggested modifications to match the partner course with their market needs		SQL/NOSQL
		Tableau
		Graph Processing

4.14 COMMUNICATIONS

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-30. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-31.

Table 4-30 Common courses in the field of Communications between partner and international countries

Communications		
Uni	**Existing Courses**	**International Courses**

WU	Communications I	Principles of Modern Digital Communications
	Communications II	Digital Communication System Design
	Communications III	Introduction to Digital Communication
	Communications IV	
SCU	Data Communications	

Table 4-31 Summery of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
EURECOM	Digital Communication System Design	Coherent Reception
		Non-Coherent Reception
		OFDM Transceivers
Suggested modifications to match the partner course with their market needs		DDS
		Modbus

4.15 COMPUTER ARCHITECTURE

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-32. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-33.

Table 4-32 Common courses in the field of Computer Architecture partner and international countries

Computer Architecture		
Uni	**Existing Courses**	**International Courses**
UWA	Computer Architecture I	Computer Design and Prototyping
UWA	Computer Architecture II	Architectures and service platforms
		From the Internet to the IoT – The Fundamentals of Modern Computer

Table 4-33 Summary of the gap in the syllabi and the market needs

University Name	Course Name	Main topics that are covered in this course and not in the existing partner courses
The existing course is up to date		
Suggested modifications to match the partner course with their market needs		DMA/RDMA
		SoC

4.16 ANTENNAS AND PROPAGATION

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-34. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-35.

Table 4-34 Common courses in the field of Antennas and Propagation between partner and international countries

Antennas and Propagation		
Uni	**Existing Courses**	**International Courses**
UWA	Antennas and Propagation I	Antennas for Wireless and Body-Centric Communications
UWA	Antennas and Propagation II	

Table 4-35 Summery of the gap in the syllabi and the market needs

University Name	**Course Name**	**Main topics that are covered in this course and not in the existing partner courses**
Florida International University	Antennas for Wireless and Body-Centric Communications	body-centric wireless communications
Suggested modifications to match the partner course with their market needs		

4.17 IOT PROGRAMMING

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-30. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-31.

Table 4-36 Common courses in the field of IoT Programming between partner and international countries

Communications		
Uni	**Existing Courses**	**International Courses**
IAU	IoT Programming (with Raspberry PI, Bluetooth, Mobile Devices, and Swift)	Practical C and Java Programming, Algorithms, and Data Structure
		Introduction to Programming in Python
		Mobile Devices Programming
		Object-Oriented Programming in C++ and Java
		Programming Parallel Machines
		Programming with Python
		IoT Programming
		Introduction to Programming
		Object-Oriented Programming Fundamentals
		Programming Embedded Systems
		Low Level and Embedded System Programming

Table 4-37 Summery of the gap in the syllabi and the market needs

University Name	**Course Name**	**Main topics that are covered in this course and not in the existing partner courses**
La Trobe University	IoT Programming	IoT operating systems
		Real-time IoT Applications
Suggested modifications to match the partner course with their market needs		

4.18 ROBOTICS

This course or similar ones are being offered in many partner countries and they match similar courses taught within IoT programs of the international countries as shown in Table 4-30. The contrast in syllabi between the existing partner and international courses on the one hand and the market requirements on the other hand revealed new topics need to be added and therefore the partner courses should be updated as shown in Table 4-31.

Table 4-38 Common courses in the field of Robotics between partner and international countries

Communications		
Uni	**Existing Courses**	**International Courses**
IAU	Autonomous Mobile Robots	Intelligent Systems and Robotics
		Biologically Inspired Robotics
		Modular robots programming and swarm robotics
		Robotics and Computer Vision
		Robot Programming

Table 4-39 Summery of the gap in the syllabi and the market needs

University Name	**Course Name**	**Main topics that are covered in this course and not in the existing partner courses**
University of Essex	Intelligent Systems and Robotics	Sensors and Actuators
		Fuzzy controllers
University of the Aegean	Robotics and Computer Vision	image processing and computational vision
Suggested modifications to match the partner course with their market needs		

5 ANALYSIS OF IOT COURSES GAP

International IoT master programs have different curricula, however, most of them share similar courses. These courses represent the core unit of these postgraduate programs. We have searched over a handful number of international IoT programs to count the offered courses according to Table 4-1. These course groups where then compared to partner courses to explicitly explain the importance of some of these courses in establishing the IoT program as shown in Figure 5-1. We can clearly conclude that embedded systems, security, big data, IoT system design and networks are among the most important courses for international IoT programs.

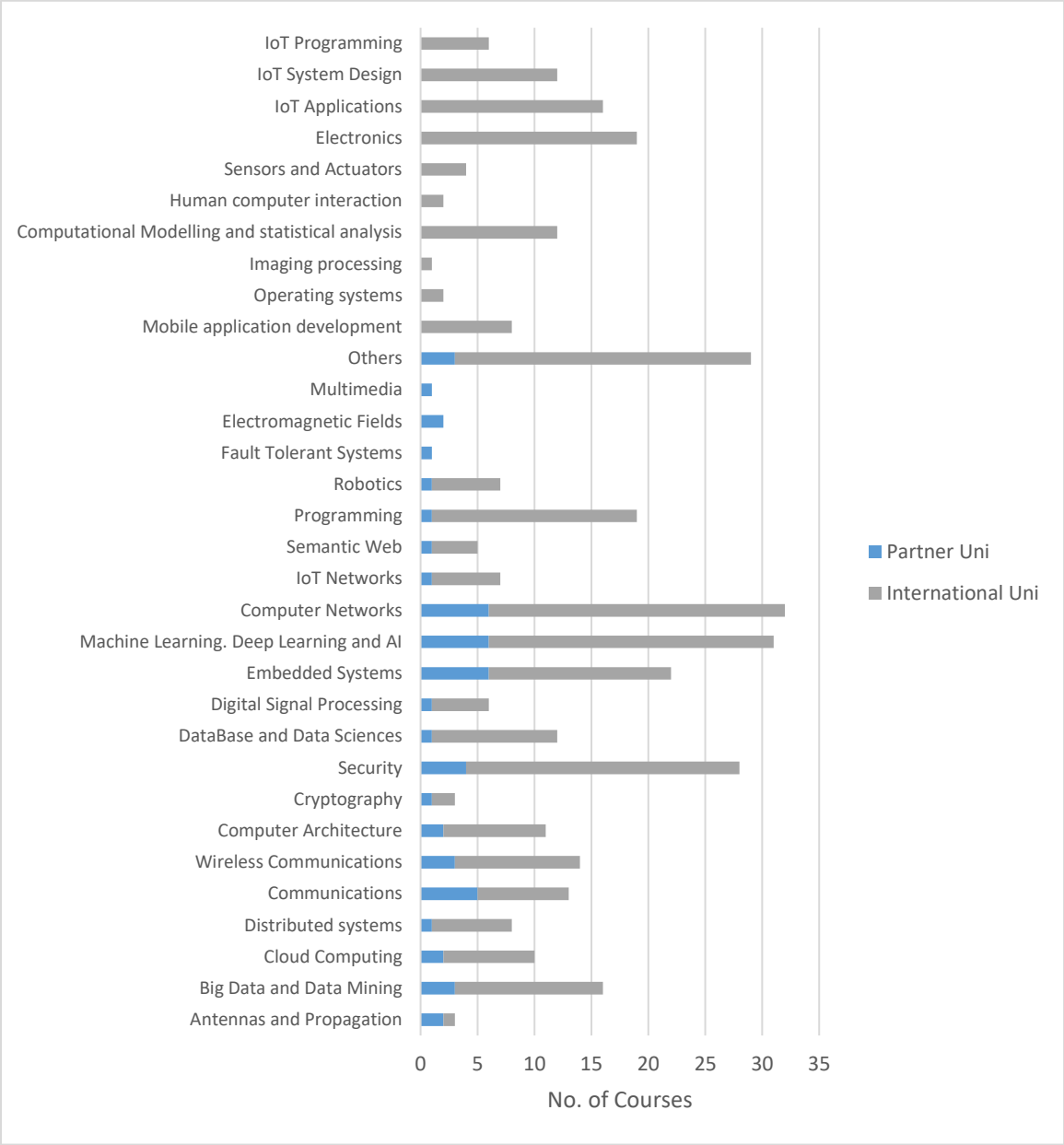

Figure 5-1 Comparison between number of courses offered in international IoT programs (gray) and partner countries (blue).

6 ANALYSIS OF MARKET NEEDS GAP

In deliverable 1.2, a survey analysis was performed to evaluate the needs of various market sectors including Government and Public Services, IoT industry, Utilities, Farming and agro-industry, Manufacturing and Mines, Oil & Gas, Health and Sports, Education, Transportation. The evaluation was driven by different factors such as IoT technology plans, IoT skills required and the level of expertise over two time points: current and expected future (5-year plan).

The stockholders' responses to the D1.2 questionnaire demonstrated different demand for the current and future requirements of the technical expertise (21 topics included in the survey as shown in Table 6-1). Figure 6-1 displays a fingerprint of the current and future (5 year) market needs of the technical expertise. It can be clearly seen that software engineering, cloud and visualization, wireless networks, and security are the most required ones among the others.

Table 6-1 IoT related technical topics using in the questionnaire.

#	Technical Topic
1	Sensors and Actuators
2	Robotics, Mechatronics & Control Theory
3	Measurement Technologies
4	Embedded / Constrained processors, SoCs and devices
5	Interfacing circuits and standards
6	Energy Efficiency & Energy sources
7	Wired Networks & Standards
8	Wireless Networks & Standards
9	Real-time systems
10	Operating Systems
11	Cloud, Virtualization and Serverless systems
12	High performance computing
13	Edge and Fog computing
14	Communication and Queuing standards, protocol stacks and libraries
15	Big Data Analytics & Visualization Solutions
16	AI, BI and Machine Learning
17	Security and Privacy
18	Blockchain Technologies
19	Industrial / Production Engineering
20	Human-machine interaction
21	Software Engineering

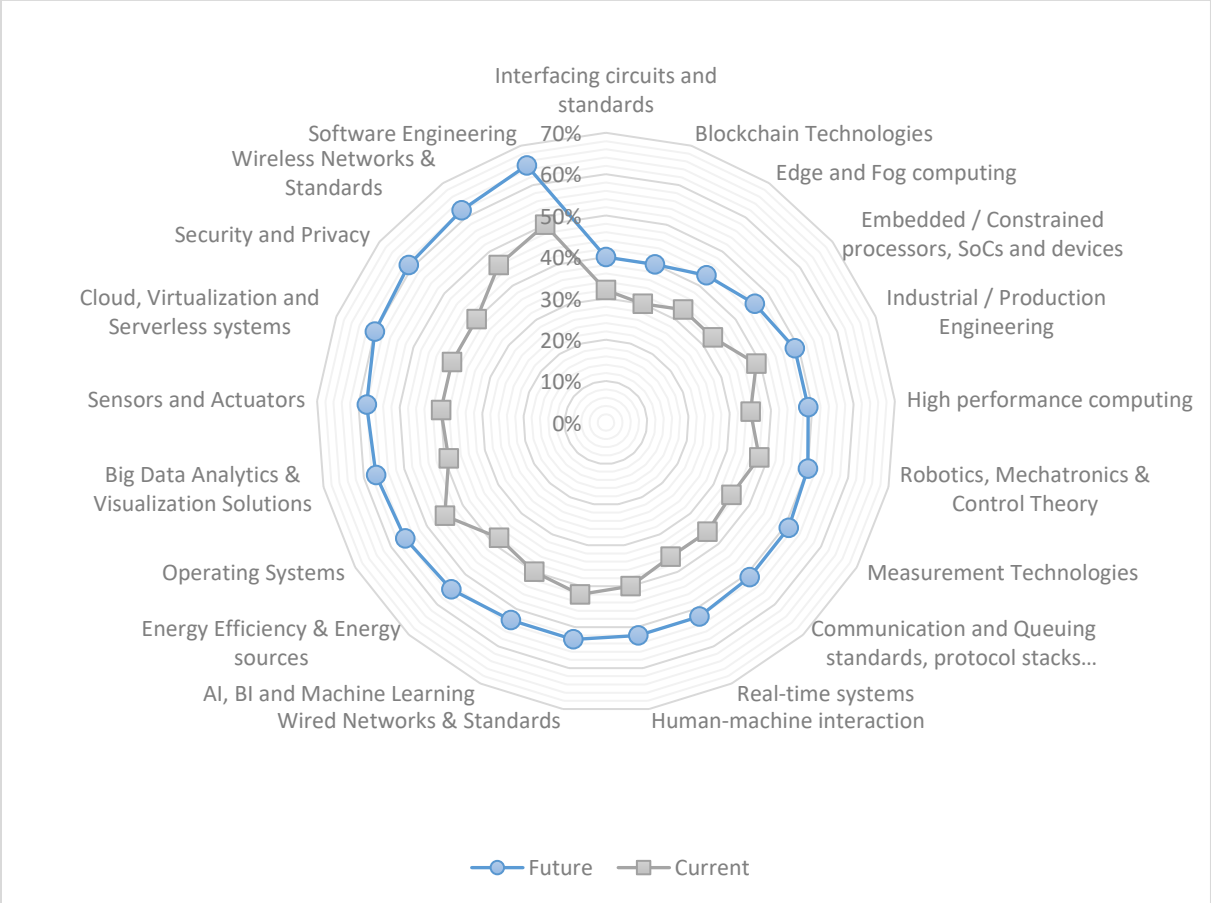

Figure 6-1 Radar graph of the current and future market needs

6.1 CURRICLE LEVEL

To draw a conclusive assessment of the existing courses and their relationship to the technical market needs listed Table 6-1, we developed an association between the existing courses in partner universities and the technical expertise demanded by the business sections. This association is shown in Figure 6-2. It can be clearly seen that the majority of the partner courses are within embedded systems, AI and software engineering themes, while courses cover operating systems, energy, cloud and fog computing, and robotics are very limited (or does not exist). Combining Figure 6-1 and Figure 6-2 revealed the strengths and weakness of the curricle of the partner universities in partially ignoring the market needs, as shown in Figure 6-3. Some courses that are significantly related to the required technical topics, for example cloud, big data, operating systems, human-machine interface, etc, need more attention.

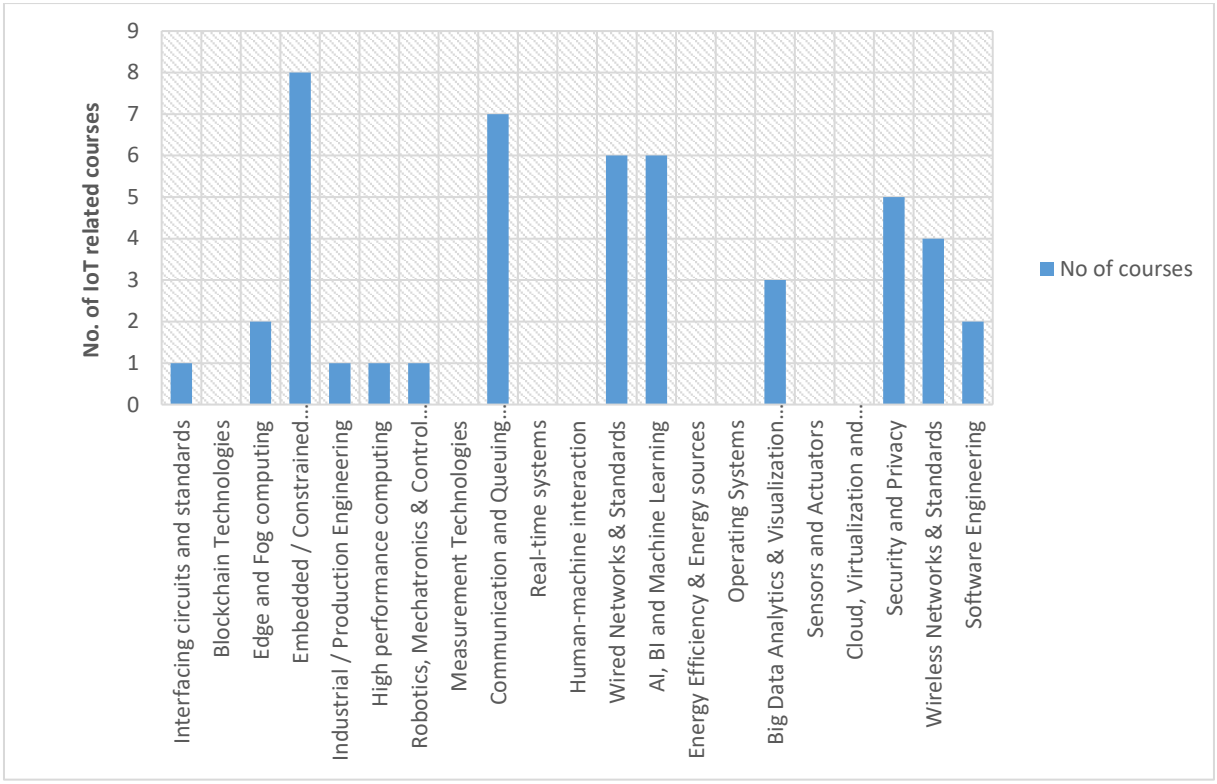

Figure 6-2 Technical topics and their associated IoT related courses

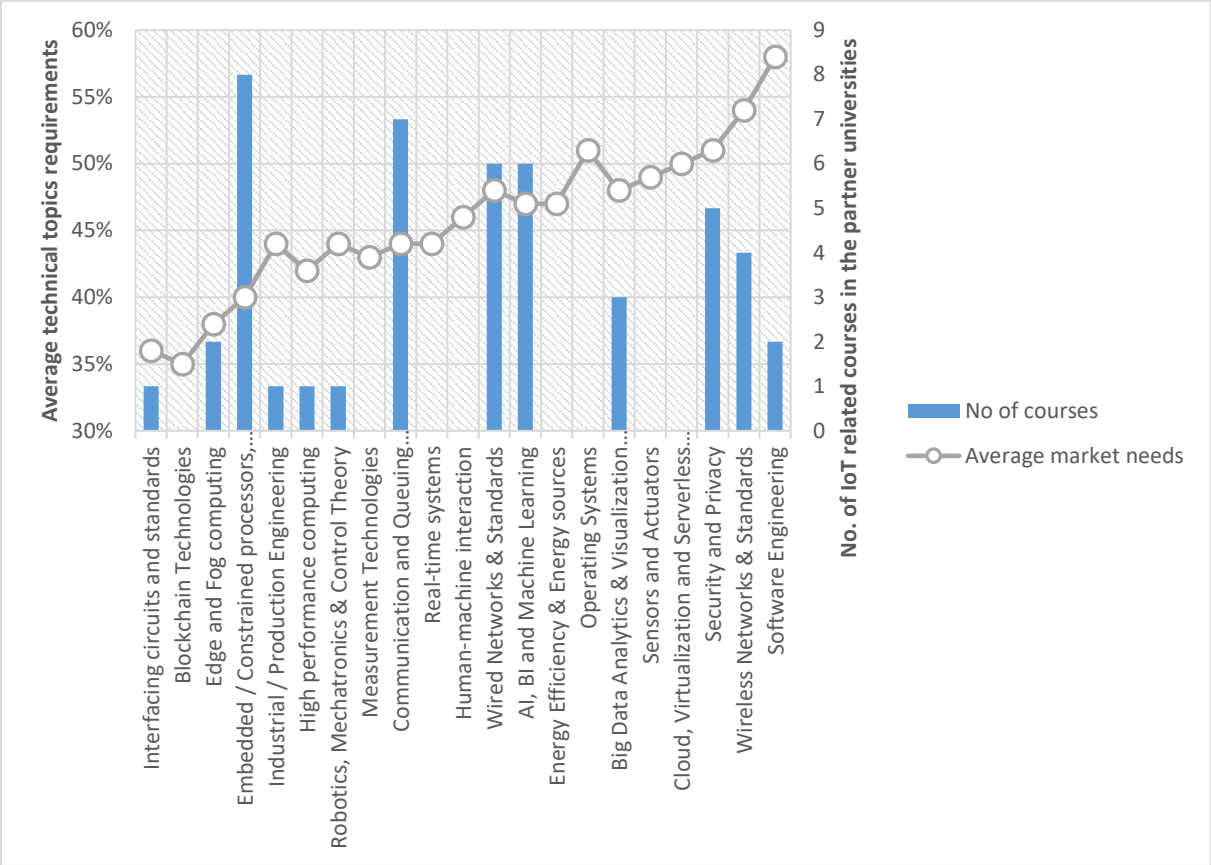

Figure 6-3 An association between the technical topics required by the market sectors and the number of existing courses in partner universities.

6.2 SYLLABI LEVEL

Deliverable 1.2 also identifies the most mentioned technologies by the stakeholders for each technical topic as listed in Table 6-2. This information could contribute to tailor the existing courses' syllabi to target the required skills.

Table 6-2 The most desirable technology of each technical topic

#	Technical Topic	Desirable Technology
1	Sensors and Actuators	RFID
2	Robotics & Control Theory	Siemens
3	Measurement Technologies	Schneider Electric
4	Embedded Systems	Raspberry pi
5	Interfacing circuits and standards	Schneider Electric
6	Energy Efficiency & Energy sources	Low energy protocols
7	Wired Networks & Standards	Ethernet
8	Wireless Networks & Standards	WiFi
9	Real-time systems	RTOS
10	Operating Systems	Android
11	High performance computing	Scientific simulation
12	Cloud, Virtualization and Serverless	Virtualization
13	Edge and Fog computing	OpenFog
14	Communication and Queuing	TCP/IP
15	Big Data	SQL/NOSQL
16	Machine Learning	Python
17	Security and Privacy	WPA/WPA2

18	Blockchain Technologies	Cryptocurrency
19	Industrial / Production Engineering	SCADA
20	Human-machine interaction	Rugged HMI
21	Software Engineering	Python

7 SUMMERY

This report presents an analyses to identify academic-industry gap in four different levels. First, the syllabi of courses taught at partner or program institutions were compared to an equivalent or similar ones offered in international university's IoT postgraduate programs. Then the existing partner curricula were compared to the international IoT program curricula to get a sense of what courses should be included throughout the course development plan (D1.5). Furthermore, the shortage in the current courses of the partner countries has been recognized based on the market needs (results of deliverables 1.2 and 1.3). Finally, a SWOT analysis was conducted for each university to assess its strengths, weaknesses, opportunities, and threats that might face and improve the specificity of the designed IoT program.

8 RECOMMENDATIONS

- Partner universities have the potential to establish new IoT postgraduate program.
- Partner universities must update their existing courses syllabi to match the ones being offered in the international IoT courses around the world.
- Few Partner universities should adapt and introduce new IoT related courses based on the market needs.
- New staff need to be hired in the Partner universities to be responsible for the teaching and the research duties.